1196

DU MONT

ELECTRONIC SWITCH

TYPE 330

Allen B. Du Mont Laboratories, Inc.

INSTRUMENT DIVISION

760 BLOOMFIELD AVENUE, CLIFTON, N. J., U. S. A.

Obviously, the design of any scientific instrument results from a series of compromises which represent the designer's opinion of an ideal instrument consistent with contemporary engineering techniques and present-day production possibilities.

In developing this instrument, an attempt has been made to incorporate those characteristics which, we believe, will satisfy the greatest number of applications.

We feel, however, that the real test of any instrument is the opinion of the man who uses it. This day-to-day test of the instrument's advantages and limitations will prove, more than any other method, just what characteristics are desirable.

Because of the nature of the equipment manufactured by Allen B. Du Mont Laboratories, Inc., it is only by complete cooperation between the customer and our Engineering Department that satisfactory designs can be achieved. In a continuous attempt to increase the applicability of our equipment to the problems of the engineer, we sincerely request suggestions advising in what manner the design of this equipment may be further extended to include these problems.

4/1996

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ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
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TABLE OF CONTENTS

page

Section 1

Technical Summary 1

Section 2

Operation 4

Section 3

Circuit Description 10

Section 4

Maintenance 14

FIGURE 1-1. TYPE 330 ELECTRONIC SWITCH

section 1
technical summary

1. Purpose

The Du Mont Type 330 Electronic Switch is designed to convert within the frequency range of d-c to 15 mc, any single-beam cathode-ray oscillograph, easily and economically, to a dual-channel instrument. It may also be used with a dual-beam instrument or several switches may be employed with a single-beam oscillograph to produce multiple channel presentations.

Since many applications of oscillography require the comparison of two or more functions, the values of multi-channel presentations are numerous. Such relationships as phase or time, input vs. output, interaction between circuits, etc. are readily explored.

2. Features

a. D-C to 15 mc unity gain identical amplifier in each channel.

b. Nine steps of compensated signal attenuation in each channel.

c. Free-running switching rates of 1 kc, 10 kc, 100 kc.

d. Triggered switching rates from 0 to 100 kc.

e. Switching triggered during sweep retrace time results in switching transients occurring off screen.

f. High impedance input; low impedance output.

g. Fine and coarse controls for establishing relative trace position on the CRT screen.

h. Regulated power supplies and amplifier heaters.

i. A compact, rugged, light weight unit is achieved through the use of printed wiring.

j. Serves as a chopper to convert an a-c oscillograph to d-c operation.

3. Technical Summary

The electrical and physical characteristics of the Type 330 are conveniently listed in the Technical Summary Sheet, Table 1-1, which follows. To aid in understanding the operation of the unit, an Over-all Functional Block Diagram, Figure 1-2, is included which illustrates the interrelation of the various circuits and controls.

TABLE 1-1.
TECHNICAL SUMMARY SHEET

GENERAL	
Name and Description of Unit	Type 330 Electronic Switch
Channels Available	Two identical—Channel A and Channel B
INPUT SYSTEM	
Input Connectors	Two Type BNC connectors (A INPUT and B INPUT) one to each channel amplifier
Type of Coupling	A-C or D-C
Input Voltage	
Capacitively coupled	600 V (d-c + peak a-c)
Direct coupled	±1 volt d-c when using the 1:1 attenuator ratio
Input Impedance	2 megohms, 45 μμf
Attenuator Ratio	1:1, 2:1, 4:1, 10:1 20:1, 40:1, 100:1, 200:1, 400:1
SIGNAL CHANNEL RESPONSE	
Sinusoidal Frequency Response	
Direct-coupling	Flat to d-c. With 60 μμf external load, response down not more than 1 db at 10 mc or 3 db at 15 mc. With 100 μμf external load, response down no more than 1 db at 6 mc or 3 db at 11 mc.
Capacitive coupling	Down no more than 30% at 5 cycles. High frequency response identical to direct coupling.

section 1
technical summary

TECHNICAL SUMMARY SHEET (Continued)
TABLE 1-1.

Pulse Response	
Rise time	0.022 microseconds with 60 μμf external load; 0.030 microseconds with 100 μμf external load
Overshoot	2% maximum
Decay at top	
Direct coupling	Zero decay
Capacitive coupling	10% in 20 milliseconds
Amplifier Gain	Approximately unity gain in each channel
Signal Amplitude	±1 volt peak input and output of each amplifier
SIGNAL CHANNEL OUTPUT	
Output Level	Zero volts d-c in the absence of signal or positioning voltage
Positioning	COARSE and FINE SEPARATION controls provide ±1 inch of positioning on an oscillograph having a d-c sensitivity of one volt per inch
Hum and Noise Level	2.5 millivolts maximum exclusive of switching transients

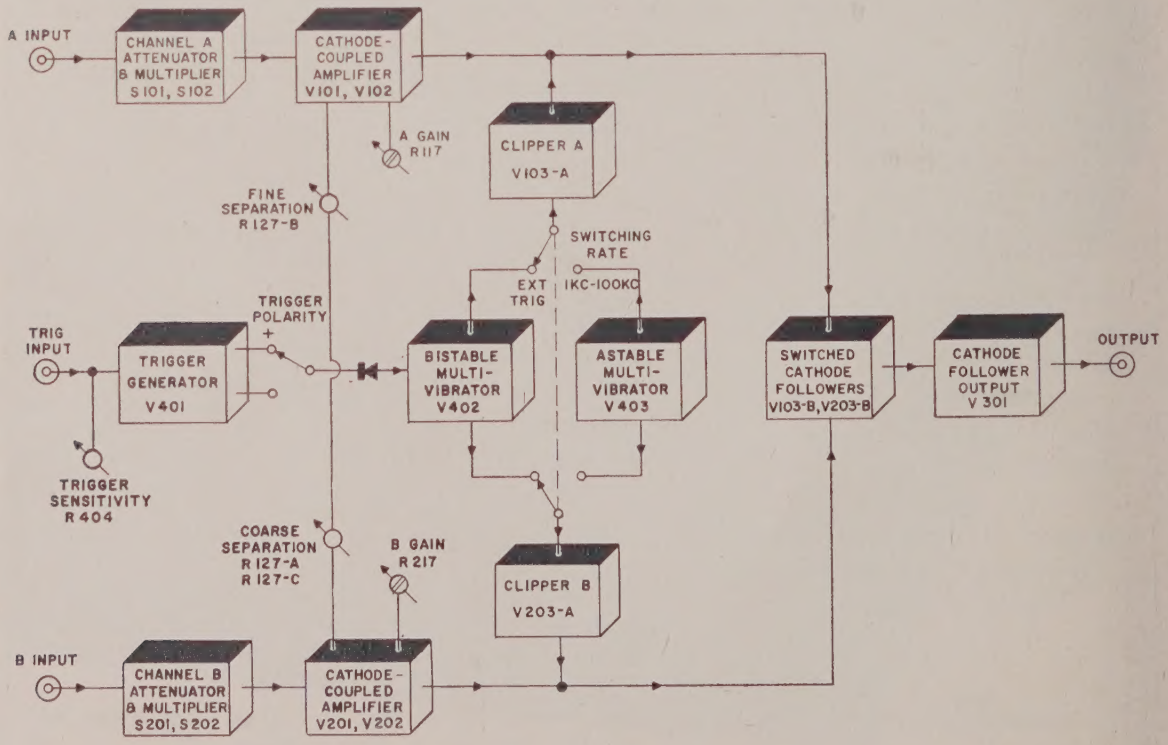


FIGURE 1-2. OVER-ALL FUNCTIONAL BLOCK DIAGRAM, TYPE 330 ELECTRONIC SWITCH

TABLE 1-1.
TECHNICAL SUMMARY SHEET (Continued)

SWITCHING SYSTEM	
Recurrent Operation	
Frequency	1 KC, 10 KC, 100 KC as selected by SWITCHING RATE Control
Switching signal rise time	2% (maximum) of square wave period
Switching tails	0.6 volt maximum
Square wave symmetry	Neither half of switching square wave more than 60% or less than 40% of square wave period
Triggered Operation	
Switching rate	0 to 100 KC by external signal applied to TRIG INPUT jack and with SWITCHING RATE switch in EXT TRIG position
Synchronizing voltage	At least ±2.0 volt peak with a rise of 0.02 V/μs or better
Switching tails	None (if triggered by sweep retrace from an oscillograph using retrace blanking)
POWER SUPPLY	
Primary-power Potential	115/230 volts±10%
Primary-power Frequency	50-400 cycles per second
Primary Power	160 watts at 115 volt line
Fuse Protection	
115 volt operation	3 amperes
230 volt operation	1.5 amperes
PHYSICAL CHARACTERISTICS	
Height	12-5/16 inches
Width	8-3/16 inches
Depth	18 inches
Weight	30 pounds

TUBE COMPLEMENT

OA2 – 2	6AV5GT – 1	6CL6 – 5	12AX7 – 1
5651 – 1	6BK7A – 4	6U8 – 1	12BH7 – 1

section 2
operation

1. Unpacking, Inspection and Installation

The Du Mont Type 330 Electronic Switch is shipped with all tubes in place and ready to operate. Upon receipt, and prior to operation, the instrument should be inspected for any damage incurred in shipment. To gain access to the chassis, remove the two screws from the bottom, and withdraw the unit from the cabinet.

Since this unit is portable, no special installation procedure is required. Normally it may be placed where most convenient for operation while at the same time maintaining short signal loads.

The instrument is shipped for operation from a 115 volt, 50-400 cycle, single phase power source and will operate satisfactorily with line-voltage variations of $\pm 10\%$. To change to 230 volt operation, see Section IV, Maintenance. When line-voltage variations are excessive, it is suggested that a constant-voltage transformer of suitable power rating be employed in the power line to the instrument.

2. Front-Panel Facilities

The front-panel controls and terminals of the Type 330 are identified in Figure 2-1. The markings on the front-panel are essentially self explanatory, and after carefully studying Table 2-1, which lists the functions of the various controls and terminals, the operator should find it possible to master the controls with a minimum of experimentation. Detailed instructions on the operation of the controls to make use of all the features of the unit are given in subsequent paragraphs.

3. Energizing the Equipment

To place the unit into operation connect the line cord to the power source and throw the front-panel toggle switch to the ON position. To eliminate any possibility of electrical shock, the chassis may be grounded by means of the pigtail on the power cord plug.

4. Initial Operating Procedures

a. SIGNAL CONNECTIONS

Signals to be switched by the Type 330 are connected to the coaxial terminals marked A INPUT and B INPUT on the front panel. Since both channel amplifiers have a frequency range of d-c to 15 mc any two related signals may be conveniently switched. If it is desired to view a signal on the CRO with respect to a particular voltage level, this voltage may be connected to one channel and the signal to the other. BNC/Binding Post adaptors are available and may be obtained from the Instrument Service Department for use when the signal lead is not equipped with a coaxial connector.

The switched output signals from the coaxial OUTPUT terminal are connected to the CRO vertical input jack. The amplifier amplitude-frequency response will change with the amount of capacity loading on the OUTPUT terminal. The chart on the front-panel indicates amplifier performance for two normal values of load capacity; response at other load values may be thus estimated.

b. CATHODE-RAY OSCILLOGRAPH and ELECTRONIC SWITCH ADJUSTMENTS

When unfamiliar with the operating procedure or with the signal levels to be observed, it is best to establish the following operating conditions in order to assure that both traces will appear on the CRT screen.

Cathode-ray Oscillograph	Type 330 Electronic Switch
(1) Start with low sensitivity	(1) Use appropriate free-running SWITCHING RATE
(2) Use AC coupling	(2) Employ sufficient attenuation to keep patterns on screen
(3) Set Positioning controls to center trace	(3) Couple sync signal from either input jack (or other related signal) to CRO
(4) Use EXTernal sync	
(5) Set sweep rate to display several cycles on screen	

Then adjust ATTENUATOR, MULTIPLIER and the sweep rate controls to obtain the required patterns on the cathode-ray tube screen. Adjust oscillograph sensitivity so that on-screen deflections will not exceed signal handling capabilities of the switch amplifiers.

Once both required traces are obtained, the signals may be direct coupled to the oscillograph vertical amplifier. A front-panel control "OUTPUT D-C ZERO ADJ" is provided which permits the operator to establish the average value of the output at zero volts d-c with respect to ground. Correct adjustment of this control prevents pattern shift as the oscillograph attenuator is shifted from one d-c position to another.

5. Triggered or Free-Running Switching

a. GENERAL

The operator may select the rate at which switching occurs by means of the SWITCHING RATE control on the front-panel. Internally controlled free-running rates of 1KC, 10KC and 100KC are available, as well as provisions for EXTernal TRIGgering of the switching circuit. *Note: During stand-by operation, use of the free-running mode will assure optimum tube life.*

b. TRIGGERED OPERATION

External control of the switching rate is obtained by connecting the triggering signal to the TRIG INPUT terminal and setting the SWITCHING RATE control to the EXT TRIG position. When the triggering signal is the positive gate or positive sawtooth output of the cathode-ray oscillograph, the switching circuit will be triggered by the negative going portion of the waveform and switching will occur during the sweep retrace time. As a result, switching transients will occur off screen. When operating in this manner, set the TRIGGER POLARITY switch to the "+" position and adjust the SENSITIVITY control to obtain stable patterns on the oscillograph screen.

Similarly, if the gate or sawtooth output is negative, throw the TRIGGER POLARITY to the "—" position. Switching will still occur during the retrace time of the oscillograph sweep.

Generally, in the majority of cases, triggered operation will result in the cleanest presentation on the screen. There are cases however, where this type of operation is not desirable or may not be used at all. As the sweep repetition rate decreases, switching rate also decreases, resulting in considerable flicker on the screen. At very low sweep rates, two distinct traces are seen alternately, making this type of operation no longer useful for two trace presentation. In other cases, free-running operation results in equally good presentations without the necessity of connecting to the oscillograph gate output or adjusting the SENSITIVITY control.

WARNING

Potentials as high as 600 volts exist in the Type 330. Such voltages are dangerous, and every possible safety precaution should be taken to avoid contact with them. The instrument is not a hazard when enclosed in its cabinet. It should not be operated outside of its cabinet except for purposes of adjustment or repair, at which times precautions should be taken as described in Section IV, Maintenance.

c. FREE-RUNNING OPERATION

Free-running switching rates (of approximately the values indicated) are selected by rotating the SWITCHING RATE control. No connection to the oscillograph gate or sawtooth output is required. The fastest single transient which may be successfully observed is determined by the highest free-running switching rate available and by the number of intervals which are required to study the waveforms under observation.

Using the 100 kc rate, a signal of 200 microseconds duration may be observed with 20 intervals in each trace. In special cases, where this rate is not sufficiently high, the rate may be increased by changing the value of C412. A value of 120 μμf will result in a switching rate of approximately 1 mc. Although the multivibrator will operate satisfactorily at this rate, the switching transient will occupy a very considerable portion of the switching period, resulting in a poor switching waveform.

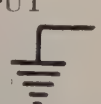
6. Synchronizing the Oscillograph

In normal operation, the oscillograph is synchronized EXTernally from one of the two input signals or from some signal related to them. In the great majority of cases, this results in the best presentation on the screen and greatest accuracy of measurement.

section 2
operation

FIGURE 2-1. FRONT-PANEL CONTROLS AND TERMINALS

TABLE 2-1.
FRONT-PANEL FACILITIES

Title	Ref Symbol	Function
CHANNEL A ATTENUATOR	S101	Concentric controls: Outer Knob — ATTENUATOR — selects input attenuation ratios of 1:1, 10:1, 100:1 either A-C or D-C
MULTIPLIER	S102	Inner knob—MULTIPLIER—selects input attenuation multipliers of 1, 2, 4, or OFF position Use of both controls give nine attenuation ratios: 1:1, 2:1, 4:1, 10:1, 20:1, 40:1, 100:1, 200:1 and 400:1
CHANNEL B ATTENUATOR MULTIPLIER	S201 S202	Same as S101 and S102
TRIGGER POLARITY	S401	Concentric controls: Outer knob — TRIGGER POLARITY — permits the trigger generator to be initiated during the CRO sweep retrace time by either a positive or negative gate output when SWITCHING RATE switch is in the EXT TRIG position
SENSITIVITY	R404	Inner knob — SENSITIVITY — A "backlash" potentiometer which establishes stable triggering of the trigger generator by signals of varying amplitude and waveshape
SWITCHING RATE	S402	Selects desired switching rate of internal recurrent gate generator; 1 KC, 10 KC or 100 KC. EXT TRIG position allows triggering by external signals (gate or saw output of the oscillograph) applied to the TRIG INPUT terminal
SEPARATION FINE	R127-B	Concentric controls: Outer knob—FINE—vernier adjustment of relative trace positioning on oscillograph screen within limits set by COARSE adjustment
COARSE	R127-A	Inner knob — COARSE — establishes the approximate relative position of the traces on the oscillograph screen
OUTPUT D-C ZERO ADJ	R521	Prevents trace shift as the oscillograph attenuator is switched from one d-c position to another
(POWER) ON	S501	Applies primary power to the power supply circuit
A INPUT B INPUT	J101 J201	Coaxial terminal: provide for connection of signals to the attenuator of each channel amplifier
OUTPUT	J301	Coaxial terminal: provide connection for coupling switched output signals to the cathode-ray oscillograph
TRIG INPUT	J401	Binding post: provide for connection of external synchronizing signals to the trigger generator when the SWITCHING RATE control is in the EXT TRIG position
 (GROUND)		Provide connection to chassis ground

section 2
operation

For normal use. INTernal synchronization is undesirable for two reasons. When using internal sync, the oscillograph attempts to synchronize with both output signals from the switch as well as the switching waveform itself. The result will usually be a distorted unintelligible pattern. Secondly, the true phase relationship of the input signals will be destroyed.

However, in some special cases it is necessary to employ internal synchronization. One of these occurs when the observed signals are not in exact harmonic relationship, as might be the case when timing markers were fed to one channel and the signal to the other. Internal synchronization may also be employed when it is desired to destroy the original phase relationship of the two signals. This is particularly valuable when comparing the input and output waveforms of a delay circuit, since the waveforms can be brought together or superimposed on the screen.

When internal synchronization is used, the best mode of switch operation depends primarily on the sweep speed and repetition rate. With sweep speeds of 10 microseconds per inch or faster and repetition rates of 5 kc or greater, best results will usually be obtained by operating the switch in the 1 kc free-running mode. With slower sweep speeds and lower repetition rates, triggered operation will generally be best.

7. Multiple Presentations

If at any time it is desired to view more than two phenomena simultaneously, it may be done by employing more than one electronic switch. Each additional switch will allow one more pattern to be presented on the screen. The number of traces which may be obtained is limited only by complexity of operation and by the lower duty cycle of each trace.

Certain operating conditions must be considered when employing multiple presentations. First of these is the amount of relative phase shift between signals introduced by the switch amplifiers. When only one switch is employed, relative phase shift is negligible. However, when more than one Type 330 is used, appreciable phase shift may occur since all signals may not pass through an equal amount of switching circuitry.

Figure 2-2 illustrates several methods of connecting units to obtain multiple presentations on the oscillograph. Installation "A" may be employed when accurately measuring the time interval between signals X and Y. The marker phase shift relative to the signals X and Y will not affect the measuring accuracy since the markers are, in effect a yardstick which may be moved with respect to the interval being measured. When three switches are connected to provide a four trace display, phase error can be eliminated by the parallel-series connection of installation "B".

These precautions concerning phase shift are important only when very short periods of time are being measured. In cases dealing with fast signals proper attention must be paid to cable length and termination.

In multiple switch operation the extent to which the triggered mode may be employed is somewhat limited, since it is always necessary to operate one of the switches in the free-running mode. Figure 2-2 also illustrates the proper methods for operation of two switch — three trace and three switch — four trace installation.

8. Applications

The principle applications of electronic switches are found in the direct comparison of signals for determining amplitude and time information. Some typical applications are:

a. Observation of the relationship of a synchronizing pulse and the synchronized function, and measurement of time delay between them.

b. Comparsion of the input and output of a delay line for waveshape and time relation. The line may be correctly adjusted even when the test square wave is not perfect.

c. Checking the input and output of counter circuits and frequency multipliers.

d. Observation of the action of a coincidence circuit by using two electronic switches and a three trace pattern.

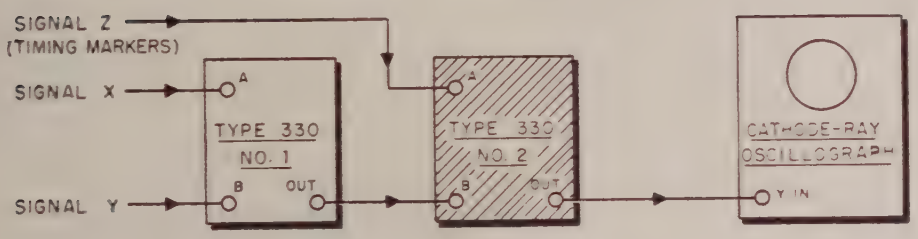
e. Observation of related signals in color television work.

f. The switch may be used to provide a d-c reference line for signals applied to one channel.

g. The switch may be used as a chopper to enable d-c operation of an a-c coupled oscillograph.

h. Accurate measurement of time through the use of timing markers applied to one channel. To measure time between two signals, use a two switch — three trace display, as described in the paragraph on multiple presentations.

A. TWO SWITCH-THREE PATTERN SETUP



B. THREE SWITCH-FOUR PATTERN PARALLEL SERIES SETUP

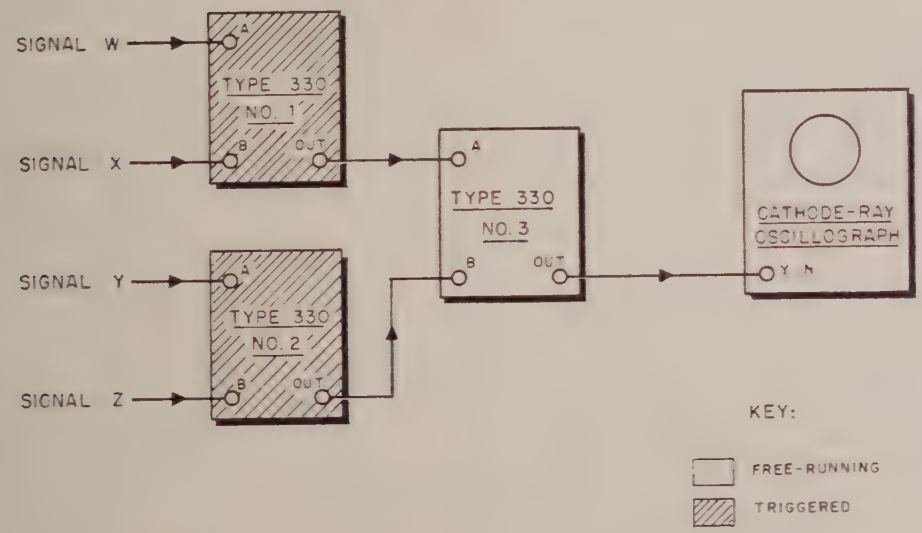


FIGURE 2-2. CONNECTIONS FOR MULTIPLE PRESENTATIONS

section 3
circuit description

1. General

In following the circuit theory discussion, it is suggested that the over-all block diagram of the Type 330, Figure 1-2, and the over-all schematic diagram be referred to in addition to functional diagrams found in this section.

2. Input Attenuator System

The attenuator system of the 330 is composed of two conventional r-c compensated attenuators in series, called respectively, the ATTENUATOR and the MULTIPLIER. The input ATTENUATOR section has steps of 1, 10 and 100; the output MULTIPLIER section has steps of 1, 2, and 4. Together they provide attenuation steps of 1, 2, 4, 10, 20, 40, 100, 200, and 400.

3. Amplifier Circuit

Since the amplifier circuit is identical in each channel, discussion will be limited to that in Channel A. The amplifier stage has two functions:

a. It provides sufficient amplification to bring the over-all switch gain to unity.

b. It isolates the switching action from the input circuitry.

A cathode-coupled amplifier, V101 and V102, is used with the following advantages:

a. It provides gain without inversion.

b. Good linearity for a single-ended stage.

c. A low impedance cathode circuit provides a point for gain control.

d. A free grid is provided for positioning.

The signal output is taken from the shunt peaked (by L102) plate circuit of V102. The output from the plate of V101 provides a neutralizing function which will be described in subsequent paragraphs.

4. Switching Action *(See Figure 3-1)*

The signal and the gating square wave from the clipper, V103-A are mixed in the plate circuit of V102. R122 increases the clipper load and thus the size of the gating waveform. Signals mixed with the gates are applied to the grids of the switched cathode followers, V103-B and V203-B, Channels A and B respectively. The gating waveforms applied to these tubes are

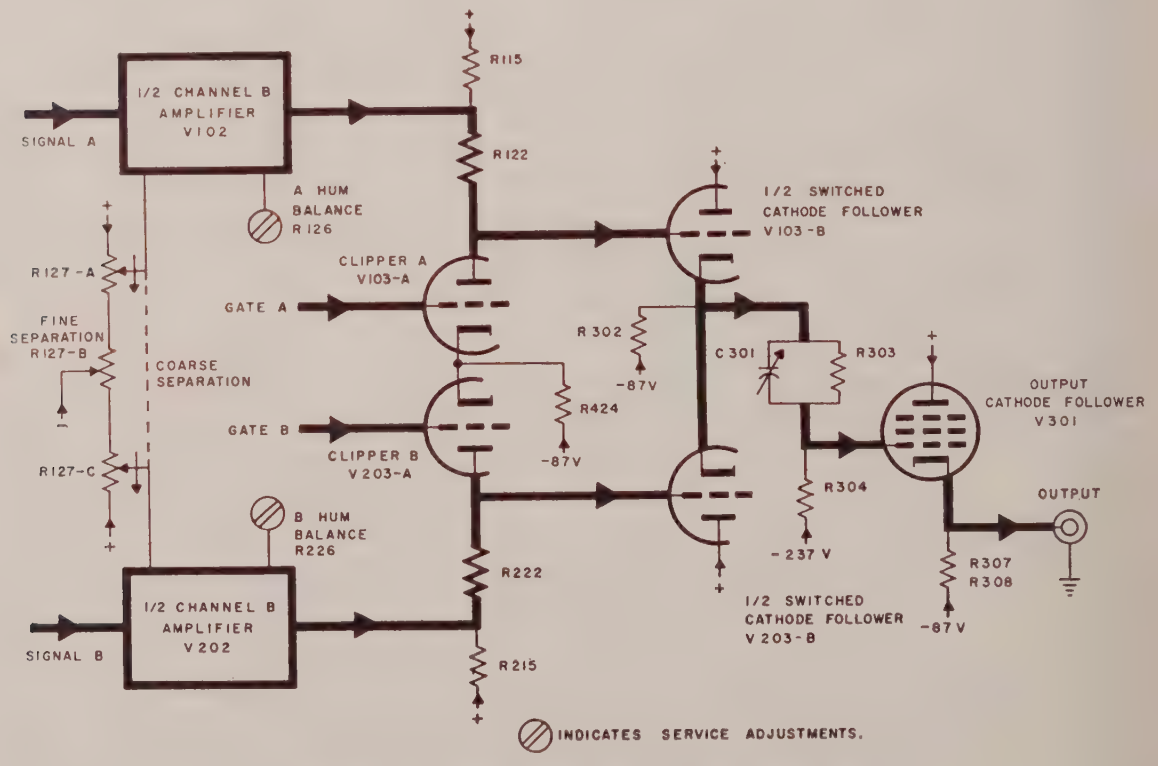


FIGURE 3-1. SWITCHING AND OUTPUT CIRCUITS

opposite in polarity, thus, V103-B and V203-B are alternately conducting and nonconducting.

Since, in the absence of positioning voltage, the gating waveforms cancel each other out, only the input signals are seen at the cathode of V103-B and V203-B. This switched cathode follower stage is the heart of the switching circuit and has the unique property of suppressing switching transients or "tails." These tails result from the switching of current from one tube to the other, which causes a voltage discontinuity to appear across the common load. This discontinuity manifests itself in the form of a spike or tail.

The switched cathode follower stage suppresses these tails because of the common cathode degenerative action, which limits the current through the cathode load to slightly more than it is at the time when one tube is cutoff and only one tube is at its normal positive operating bias.

5. Output Circuits *(See Figure 3-1)*

The switched signals from Channel A and Channel B which appear alternately at the cathode of V103-B and V203-B are coupled to the output cathode-follower, V301, by means of the grid bleeder composed of R303 and R304. High frequency compensation for this bleeder is provided by C301 in the conventional manner for r-c attenuators. This bleeder provides a bias for V301 which places the cathode of V301 at zero volts d-c in the absence of positioning or signal voltages. This permits the succeeding oscillograph to be d-c coupled. The cathode follower, V301, provides a low impedance output for driving the oscillograph without deterioration in frequency response.

6. Gating Waveform Circuits *(See Figure 3-2)*

In free-running operation, the gating square wave is generated by the cathode-coupled multivibrator (V403) which uses both cathode and plate to grid coupling to maintain oscillation. The frequency of the multivibrator is determined by the cathode circuit components, thus permitting simple switching in the low impedance part of the circuit. Although the square waves at the plates of the multivibrator have good rise time, the top and bottom are not sufficiently flat for direct use in switching. To correct this, the square waves are fed to the clipper tubes, V103-A and V203-A, which produce waveforms at the plates that have clean flat tops and rounded bottoms. The rounded bottom is clipped off in the switching action by driving the switched cathode followers well beyond cutoff.

R424, in the cathode circuit, maintains the cathodes of the clippers at the proper d-c potential. The voltage across R424 is almost constant because the current through V103-A, when it is conducting, is approximately the same as that through V203-A. Thus, the cathode circuit of V103-A and, V203-A may be considered to be the plate supply voltage point for the multivibrator. The clipper tubes, V103-A and V203-A, are alternately cut off or at zero bias depending upon which multivibrator plate load (R420 or R421) is conducting. R420 and R421 are loads

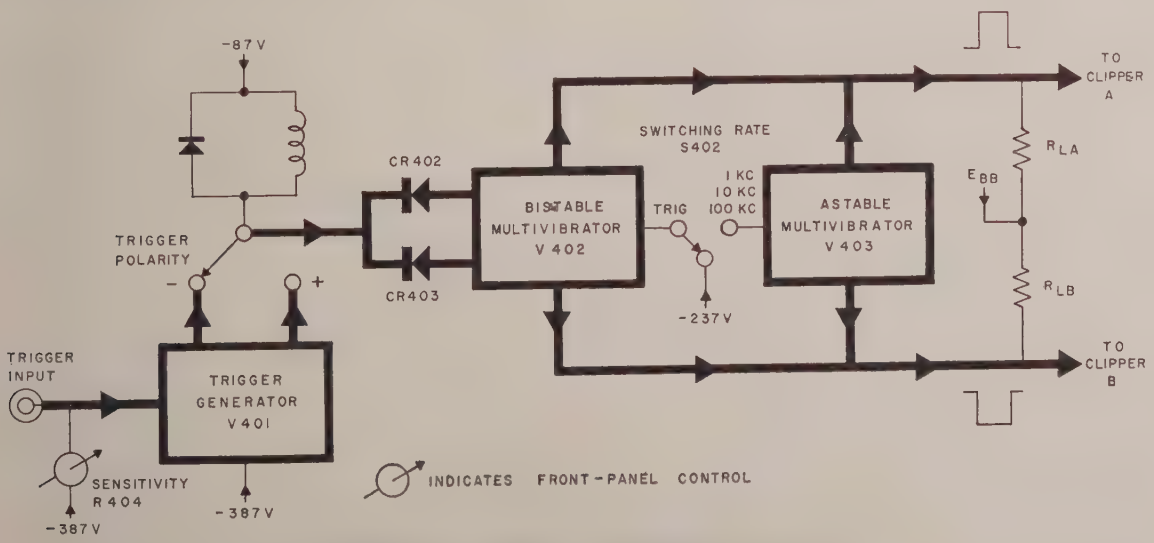


FIGURE 3-2. GATING WAVEFORM CIRCUITS

for the bi-stable multivibrator as well as for the free running multivibrator, with the result, that a similar action occurs in triggered operation. However, when the multivibrator section connected to R421 is cutoff, the current through the bleeder network of the bi-stable multivibrator flows through R421 and V203-A will not go to zero bias. To compensate for this, R221 is connected to the +120 V supply. R121 has a similar function in the grid circuit of V103-A.

In triggered operation, the free running multivibrator is disabled by opening up its negative supply line. Gating square waves are then generated by V402, a conventional Eccles-Jordan bistable multivibrator. Satisfactory triggered operation with a wide variety of triggering waveforms is obtained by employing a Schmitt trigger circuit (V401). The bias on the input section of the Schmitt trigger is adjusted by means of the TRIGGER SENSITIVITY control, R404. The negative pulse output from this circuit, developed across L401 and clipped by crystal diode CR401, is satisfactory for rapid triggering of the bi-stable multivibrator. This inductance is inserted in either the input or the output section of the Schmitt trigger by means of the TRIGGER POLARITY switch. By doing this, the negative output is obtained from the Schmitt trigger at a time corresponding to either the positive going or the negative going transition of the input trigger waveform. This permits triggering action to occur during that part of the triggering waveform which corresponds to the retrace time of the oscillograph.

7. Trace Positioning

Trace separation is accomplished by varying the bias of V102 in Channel A, and V202 in Channel B. The COARSE SEPARATION potentiometers, R127-A and R127-C, are two sections of a dual potentiometer connected in opposition.

8. Neutralization of Capacitive Coupling in the Switched Cathode Followers

In spite of the low impedance of the cathode circuit of the switched cathode followers, some capacitive coupling occurs from grid to cathode of the off tube at high frequencies which appears as cross coupling of the input signals. To minimize this effect, neutralizing signals are taken from the plate of V101 in Channel A and V201 in Channel B. The neutralizing signal from Channel A is fed through the trimmer C119 to the cathode of the switching stage. In Channel A, C115 is connected from the plate of V101 to ground to make the shunt capacitance approximately equal to that at the plate of V102, thus insuring correct phase of the neutralizing signal. In Channel B, C215 and C219 have functions identical to those of C115 and C119.

9. Amplifier Neutralization

a. HUM NEUTRALIZATION

Hum neutralization in Channel A is accomplished by feeding a hum-bucking voltage from R126 to the grid of V102, through R125 and R124. The combination of R125 and C118 provide hum neutralizing signals of the proper phase. A similar arrangement is provided in Channel B.

b. PLATE RESISTANCE NEUTRALIZATION

Since V102 has a finite plate resistance, some of the switching waveform is coupled from plate to cathode through this plate resistance. Because of the common cathode configuration, the switching waveform appears also at the cathode of V101 and is capacitively coupled into the high impedance grid circuit. Amplification of this signal produces a small but objectionable overshoot on the switching waveform. To remove this effect, R120 is connected between the grid of V103-A, the clipper, and the cathode circuit of V101 and V102. A square-wave opposite in polarity to that coupled from plate to cathode of V102 is thus fed to the cathode of V103-A, cancelling the effect. R220 serves the same purpose in Channel B.

One other neutralizing connection is made in the first stage. Because of the plate to grid capacity of the clipper, V103-A in Channel A, a rounding occurs on the top of the gating waveform resulting in increased switching noise and trace width on the oscillograph. This effect is reduced by coupling a neutralizing signal to the grid of V102 through C116. A similar function is performed by C216 in Channel B.

10. Power Supply

All d-c operating potentials are derived from the regulated power supply which consists of several conventional sections. The main section produces the +120 V and the −87 V supply voltages and utilizes V502, V503 and V504. The output of a selenium rectifier full-wave voltage-doubler circuit is fed to the series regulator tube, V502, which is controlled by the cascade-con-

nected control amplifier, V503. V504 provides the voltage reference for this amplifier and the ground reference for the entire system.

The +220 V supply uses a regulator composed of two halves of V501, which are used respectively as the series regulator and control amplifier of the regulator. Input to this regulator is obtained from a half-wave doubler connected to the same winding as the doubler supply of the +120 V supply. The complete system of rectifiers and filter capacitors on this winding acts as a voltage-tripler circuit. Two –237 volt gas tube regulated supplies are provided which obtain voltage from a full-wave doubler system using selenium rectifiers. The –237 V "a" supply, regulated by V505, supplies negative potential for the output cathode follower grid bleeder and the positioning control. The –237 V "b" supply, regulated by V506, supplies voltage for the switching multivibrators. Two separate gas tube supplies are used to separate the multivibrator load from the cathode follower grid bleeder.

section 4
maintenance

1. General

Removal of the two screws at the bottom of the cabinet allows the chassis to be withdrawn for maintenance.

WARNING

POTENTIALS AS DANGEROUSLY HIGH AS 600 VOLTS EXIST IN THIS INSTRUMENT. OBSERVE THE FOLLOWING PRECAUTIONS WHEN NECESSARY TO ENERGIZE THE EQUIPMENT WITH THE CABINET REMOVED.

(1) Never work alone.

(2) Make sure the chassis is properly grounded.

(3) Disconnect power before changing any tubes.

(4) Before touching any component, short the terminals to remove any possible charge that may remain after removing the power.

The first step in correcting any trouble or failure that may occur is to isolate the section of the circuit causing the trouble. Such isolation can be accomplished by considering the circuit as composed of the basic sections shown in the over-all block diagram, Figure 1-2.

The next step after isolating the trouble to a particular section is to determine the specific tube circuit involved. A replacement tube should be tried before attempting any other test. *Indiscriminate tube changing must be avoided. If after tube replacement, the trouble persists, replace the original tube in its socket.* NOTE: Replacement of certain tubes will require resetting on one or more service adjustments. Consult Table 4-2 for special instructions. If trouble persists, voltage and resistance measurements should be made.

2. Maintenance Reference Data

a. OVER-ALL SCHEMATICS

An over-all schematic of the circuits will be found at the back of this section and should be consulted while trouble shooting. A list of the component electrical parts, including descriptions, is also provided.

b. TROUBLE SHOOTING CHART

As an aid in servicing, Trouble Shooting Chart, Table 4-1, indicates symptoms, probable causes of trouble and remedies.

c. VOLTAGE AND RESISTANCE MEASUREMENTS

Table 4-3 lists voltages and resistances from tube pins to ground except as otherwise noted. Voltage measurements shown were taken using a vacuum-tube voltmeter. Good judgment is often required to determine if a particular deviation from the value shown is indicative of trouble.

d. TUBE LOCATIONS

Tubes may be located by reference to Figure 4-3.

e. WAVEFORM DATA

Checking with a cathode-ray oscillograph for the presence of the correct waveform at critical points in the circuit aids greatly in the diagnosis of circuit or component failure. Sketches of waveforms are shown on the over-all schematic diagram at the exact point at which they occur. In addition, the approximate peak-to-peak voltage amplitude of each waveform is given.

For waveforms of free-running operation, set the appropriate front-panel controls as follows:

Control	Setting
CHANNEL MULTIPLIER	OFF
COARSE & FINE SEPARATION	center of range
SWITCHING RATE	100 KC
TRIGGER SENSITIVITY	fully CCW

For waveforms of triggered operation, set SWITCHING RATE at EXT TRIG, couple the sawtooth output from an oscillograph (304-A) to the TRIG INPUT terminal (sweep rate approximately 10 kc), and set SENSITIVITY to obtain best triggering

3. 230-Volt Operation

To change from 115-volt to 230-volt line operation, first turn off the power. Withdraw the chassis from the cabinet and set the 115/230-volt selector (Figure 4-4) to 230-volt. Change the line fuse from 3A to 1.5A.

4. Service Adjustments

a. GENERAL

Service adjustments may be identified by reference to the call-out photographs, Figures 4-2 through 4-4. Do not touch any service adjustment unless tests indicate clearly that it is necessary to do so. Such adjustments should not be attempted without complete understanding of the proper procedure. Certain service adjustments, listed in Table 4-2, may need to be reset when replacing tubes. Before making any adjustments a one minute warm-up period must be allowed.

b. POWER SUPPLY CIRCUITS

(1) +220-volt ADJ (R504 — See Figure 4-2) Check the d-c voltage from Pin 3 of V501 to ground. If not + 220-volts, adjust R504 to bring voltage to this value.

c. CHANNEL A AND CHANNEL B AMPLIFIERS

(1) A GAIN and B GAIN (R117 and R217 —See Figure 4-2)

Apply a 1 kc square wave of 1-volt amplitude to a cathode-ray oscillograph and adjust gain for full-scale deflection. Then apply it to Channel A, couple the 330 to the oscillograph, and set the CHANNEL A ATTENUATOR and MULTIPLIER to the "1" position. Adjust the A GAIN control for full-scale deflection. The amplifier will then have unity gain. Repeat procedure for CHANNEL B.

(2) A HUM BALANCE AND B HUM BALANCE (R126 and R226 — See Figure 4-2)

Connect the switch OUTPUT to a cathode-ray oscillograph having a sensitivity of 100 mv full scale (25 mv/in). Set CHANNEL ATTENUATORS and MULTIPLIERS in the "1" position. Hum should not exceed 2.5 mv (0.1 inch) in either channel. If hum is greater, adjust the proper HUM BALANCE control for minimum.

(3) CHANNEL A AND CHANNEL B NEUTRALIZING TRIMMERS (C119 and C219 — See Figure 4-2)

Check CHANNEL A TRIMMER by coupling a 1 mc square wave-signal to the A INPUT and setting the CHANNEL A ATTENUATOR and MULTIPLIER at 1. Set CHANNEL B ATTENUATOR to 100, MULTIPLIER at OFF, and employ free-running operation. Cross-coupled signal should be no more than 0.004-volt. If it is, adjust C119 for minimum amplitude. CHANNEL B TRIMMER is adjusted in the same manner.

(4) CHANNEL ATTENUATORS AND MULIPLIERS (See Figure 4-3)

Check attenuators by applying a 10 kc square wave to the Channel A input and observing the output on an oscillograph. A flat-top square wave pattern should be observed on all steps. If not, first check the setting of the output cathode follower trimmer, C301. If this is correct, obtain proper pattern by adjusting the trimmer capacitors according to the following table:

Step	Control Setting		Adjust
	Attenuator	Multiplier	
(a)	1	2	C110
(b)	1	4	C111
(c)	100	1	C106
(d)	10	1	C103
(e)	10	2	C108
(f)	10	4	C109
(g)	Connect an attenuator probe in series with A INPUT		
(h)	1	1	Probe Trimmer
(i)	10	1	C102
(j)	100	1	C105

CHANNEL B ATTENUATOR and MULTIPLIER are adjusted in the same manner. Figure 4-1 illustrates correct and incorrect trimmer adjustment.

d. OUTPUT CATHODE FOLLOWER TRIMMER (C301—See Figure 4-2)

The high-frequency compensation trimmer C301, for the grid circuit of the output cathode follower should be adjusted for optimum square wave response. To check setting, apply a 100 kc

square wave to either INPUT terminal, set the channel ATTENUATOR and MULTIPLIER at 1, and employ External synchronization to the oscillograph. A flat-top square wave pattern should be observed. If not, adjust C301 accordingly. This adjustment should be made before attenuator adjustment.

5. Du Mont "Oscillographer"

The Du Mont "Oscillographer," a periodical, is published by the Allen B. Du Mont Laboratories, Inc., and is sent free of charge to engineers, research workers, and those engaged in the use and application of cathode-ray equipment. When sending in subscriptions or when sending notification of change of address, please supply the following information: name, company name, company address, type of business, and title of individual.

6. Du Mont Warranty

All instruments produced by the Instrument Division of Allen B. Du Mont Laboratories, Inc., are sold under the Du Mont Warranty. For the provisions of this warranty, see the Warranty and Service Notice on the inside back cover.

7. Service

The Instrument Division maintains complete facilities for servicing Du Mont equipment. For details of the Instrument Service policies, see the Warranty and Service Notice on the inside back cover.

TABLE 4-1. TROUBLE SHOOTING CHART

POWER SUPPLY CIRCUITS

Symptom	Probable Cause	Remedy
Pilot light does not light	Blown fuse; line cord disconnected	Replace fuse.
Output not adjustable to dc zero	Incorrect power supply potentials	1. Check +120 V and –87 V supplies. 2. Check potentials at socket pins of V502 and V503.
	R303 or R304 incorrect value	Measure and replace if incorrect.
Excessive 120 cycle ripple	Defective regulator control tube	1. Replace V503 2. Replace V501
Excessive 60 cycle hum; same in both channels	C514 defective	Check hum on –87 V supply. (Should be less than 1 mv p-p.)
Low level oscillation in output	–237 V "a" voltage regulator oscillating	Replace V505

(A) Correct Waveform (B) Overcompensated (D) Undercompensated

FIGURE 4-1. WAVEFORMS ENCOUNTERED IN ADJUSTING ATTENUATOR AND MULTIPLIER COMPENSATION CAPACITORS

TABLE 4-1. TROUBLE SHOOTING CHART (Continued)

CHANNEL AMPLIFIERS

Symptom	Probable Cause	Remedy		
			CHANNEL A	CHANNEL B
Excessive 60 cycle hum; one channel only	HUM BALANCE improperly adjusted	ADJUST	R126	R226
	Bad hum characteristics of amplifier tubes	REPLACE	V102 V101	V202 V201
Traces cannot be superimposed	Poor connection in one of the amplifiers	1. Make sure all tubes are in sockets and filaments lit. 2. Check continuity to ground from grid of 1st stage.		
	Defective tube in amplifier	3. Check continuity from grids of V102 and V202 to SEPARATION control. 4. Check amplifier potentials at tube sockets (V101, V102, V201, V202).		
Excessive cross coupling of edges of fast rising signals	Improper adjustment of neutralizing capacitors	Adjust C119, C219.		
Excessive drift, especially of one channel relative to the other	Defective current regulator	Replace RT501.		

SWITCHING AND OUTPUT CIRCUITS

Symptom	Probable Cause	Remedy
Slope on top or bottom of 1 kc switching square wave	Low plate current in clipper section of V103 or V203	Turn SEPARATION so that channel A is up. If slope is on top of square wave, replace V103. If slope is on bottom, replace V203.
Double trace not available in free-running operation	Defective astable multivibrator (V403)	Replace V403. Check V & R according to Table 4-3.
Double trace operation not obtainable in triggered operation	Defective 6U8 (V401) in Schmitt trigger circuit	Replace V401
	Defective 6BK7 (V402) in bistable multivibrator	Replace V402
	Trigger diodes defective	Replace CR402, CR403
	Shunt diode defective	Replace CR401
Excessive vertical jitter in output	Noisy resistors in grid bleeder of output cathode-follower	Replace R303, R304
	Noisy resistors in power supply regulator bleeder	Replace R518, R517, R513, R519, R520.

TABLE 4-1.
TROUBLE SHOOTING CHART (Continued)

SWITCHING AND OUTPUT CIRCUITS		
Symptom	**Probable Cause**	**Remedy**
Excessive cross coupling from trigger circuit to output circuit. (TRIGGER POLARITY switch in proper position)	Low back resistance of trigger diodes	Replace CR402, CR403.
	High forward resistance of shunt diode	Replace CR401
Slope on 100 kc switching square wave and on signals	Improper adjustment of output cath foll grid bleeder trimmer	Adjust C301
Feed through of low frequency signals of maximum amplitude within specified signal handling of switch (Varies with separation)	"Off" tube of switched cathode followers driven into conduction. Clipper-gate tube in channel having cross coupling has low plate current in clipper section or remote cutoff in gated section	1. Replace V103 for feed through from Channel A. 2. Replace V203 for feed through from Channel B.
Excessive assymetry of free - running switching square wave	Unmatched sections of astable multivibrator tube	Replace V403.

TABLE 4-2.
ADJUSTMENTS REQUIRED FOLLOWING TUBE REPLACEMENT

Tube Reference Symbol	Tube Type	Service Adjustment
V101	6CL6	A GAIN (R117), A HUM BALANCE (R126)
V102	6CL6	A GAIN (R117), A HUM BALANCE (R126)
V201	6CL6	B GAIN (R217) B HUM BALANCE (R226)
V202	6CL6	B GAIN (R217) B HUM BALANCE (R226)
V501	12BH7	+220 ADJ (R504)

TABLE 4-3. VOLTAGE AND RESISTANCE MEASUREMENTS

Preset front-panel controls according to the following chart:

Control	Position
A & B ATTENUATOR	1 A-C or D-C
A & B MULTIPLIER	1
COARSE SEPARATION	Center of range
FINE SEPARATION	Center of range
SWITCHING RATE	1 KC
TRIGGER POLARITY	+
SENSITIVITY	Center of range

Tube			Pin Numbers									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V101	6CL6	½ Cath-coupled Amplifier Channel A	2.5V 100K	NC NC	118V 46K	└6.3 250	VAC┘ 250	112V 46K	0V 0	118V 46K	0V 2M	
V102	6CL6	½ Cath-coupled Amplifier Channel A	2.5V 100K	0V 250K	118V 46K	└6.3 250	VAC┘ 250	103V 46K	0V 0	118V 46K	0V 250K	
V103	6BK7A	(A) Clipper A (B) ½ Switched Cath. Foll.	102V 46K	–31V 88K	–23V 88K	└6.3 250	VAC┘ 250	220V 390K	102V 46K	108V 102K	0V 0	
V201	6CL6	½ Cath-coupled Amplifier Channel B	2.5V 100K	0V 2M	118V 46K	└6.3 250	VAC┘ 250	112V 46K	0V 0	116V 46K	NC NC	
V202	6CL6	½ Cath-coupled Amplifier Channel B	2.5V 100K	0V 250K	118V 46K	└6.3 250	VAC┘ 250	103V 46K	0V 0	116V 46K	0V 2M	
V203	6BK7A	(A) Clipper B (B) ½ Switched Cath. Foll.	102V 46K	–31V 88K	–23V 88K	└6.3 250	VAC┘ 250	220V 390K	102V 46K	108V 102K	0V 0	
V301	6CL6	Cath. Follower Output	0V 92K	–1.8V 182K	118V 46K	└6.3 250	VAC┘ 250	118V 46K	0V 92K	118V 46K	–1.8V 182K	
V401	6U8	Schmitt Trigger Generator	–87V 100K	–237V 2.6M	–87V 100K	–145V └6.3 340K	–145V VAC┘ 340K	–88V 100K	–225V 140K	–255V 140K	–257V 180K	
*†V402	6BK7A	Bistable Multivibrator	–94V 99K	–170V 210K	–170V 140K	–145V └6.3 340K	–145V VAC┘ 340K	–30V 99K	–200V 210K	–170V 139K	0V ∞	
V403	6BK7A	Astable Multivibrator	–31V 94K	–149V ∞	–160V 145K	–145V └6.3 340K	–145V VAC┘ 340K	–31V 94K	–149V ∞	–160V 145K	0V 0	
V501	12BH7	(A) +220V Series Regulator (B) +220V Reg. Amplifier	380V 400K	215V 1M	220V 390K	175V 380K	175V 380K	215V 1M	118V 390K	118V 46K	175V 380K	
V502	6AV5-GT	+120V Series Regulator	111V 1M	175V 380K	118V 46K	NC NC	209V 47K	NC NC	175V 380K	202V 390K		
V503	12AX7	+120V Regulator Amplifier	66.5V ∞	–0.5V 320K	0.05V 1K	62V 140K	62V 140K	111V 1M	66V 126K	66.5V ∞	62V 140K	
V504	5651	Voltage Reference	0.05V 1K	–87V 100K	NC NC	–87V 100K	0.05V 1K	NC NC	–87V 100K			
V505	OA2	–237V "a" Regulator	–87V 100K	–237V 139K	NC NC	–237V 139K	–87V 100K	NC NC	–237V 139K			
V506	OA2	–237V "b" Regulator	–87V 100K	–237V 135K	NC NC	–237V 135K	–87V 100K	NC NC	–237V 135K			

NOTES: 1. All resistance and voltage measurements taken from the tube socket to ground using VTVM, except as noted.
2. All voltages are d-c and positive with respect to chassis, except where otherwise indicated.
3. * SWITCHING RATE switch in EXT TRIG position.
4. † Voltage readings at Pins 1 and 2 may be interchanged with those at 6 and 7 respectively. (Bistable circuit.)

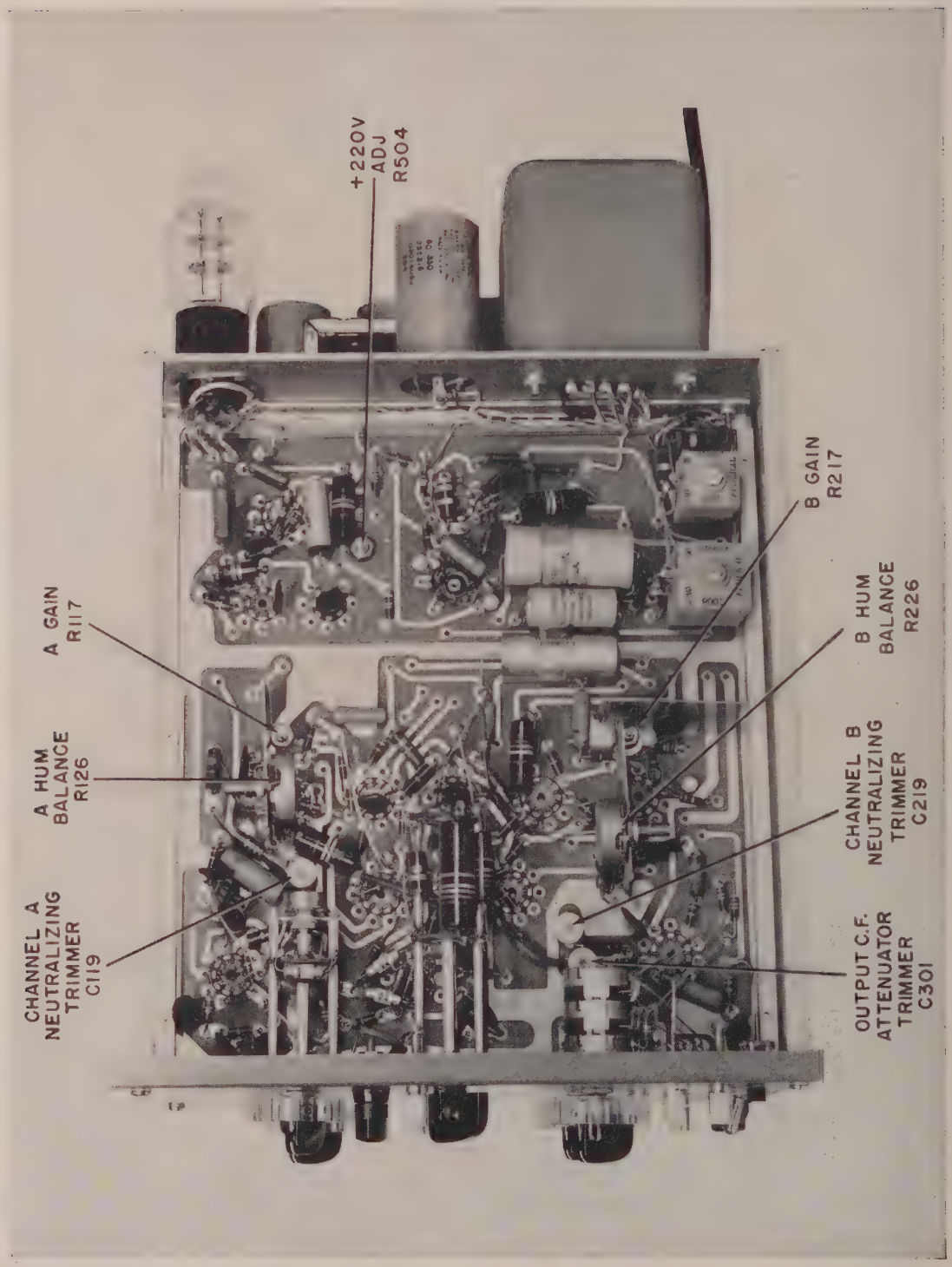

+220V ADJ R504
A GAIN R117
A HUM BALANCE R126
CHANNEL A NEUTRALIZING TRIMMER C119
B GAIN R217
B HUM BALANCE R226
CHANNEL B NEUTRALIZING TRIMMER C219
OUTPUT C.F. ATTENUATOR TRIMMER C301

FIGURE 4-2. SERVICE ADJUSTMENTS, RIGHT SIDE

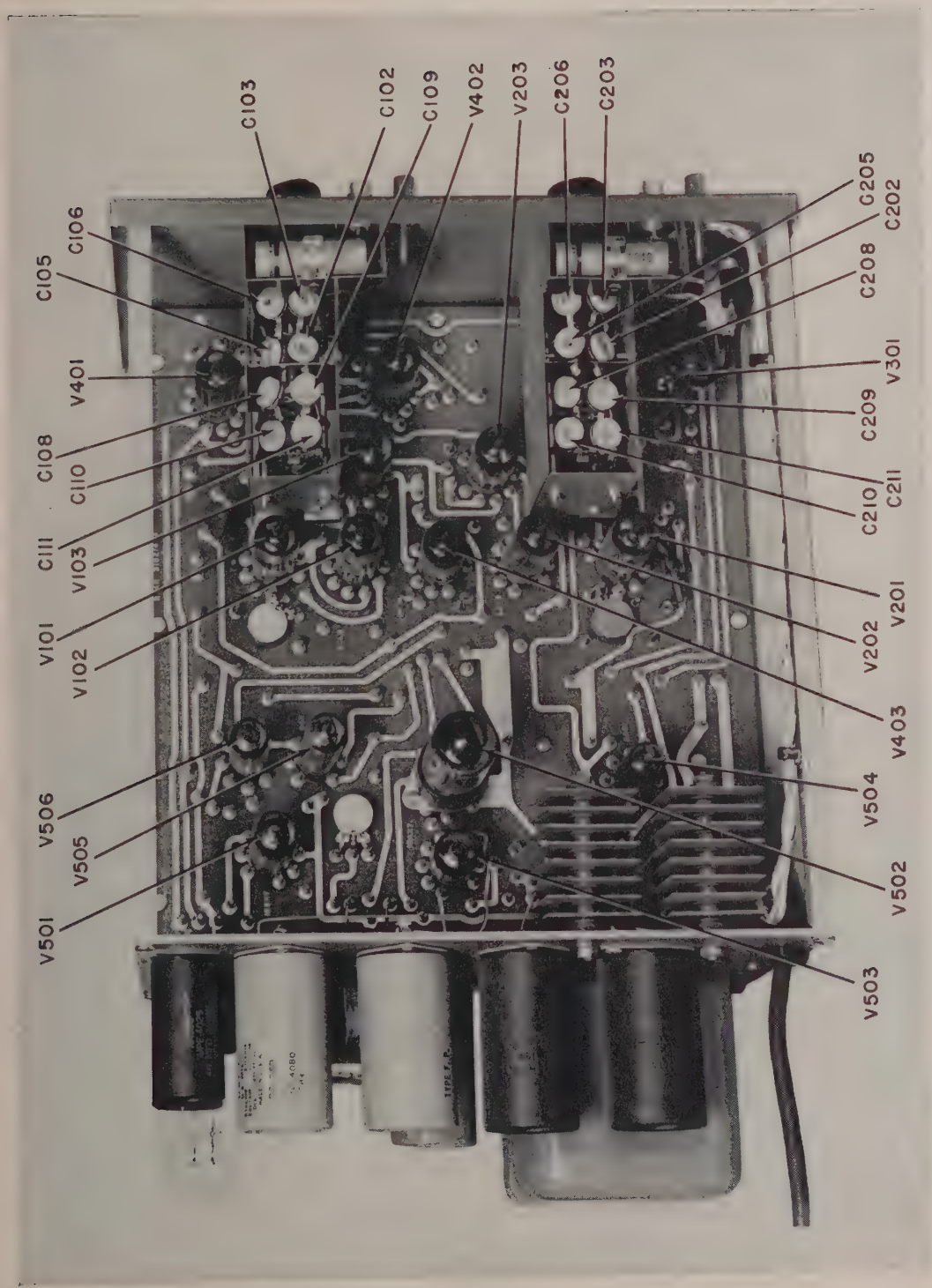


FIGURE 4-3. SERVICE ADJUSTMENTS AND TUBE LOCATIONS, LEFT SIDE

FIGURE 4-4. REAR VIEW SHOWING ELECTROLYTIC CAPACITORS; FILAMENT REGULATOR AND 115/230 V SELECTOR

NOTES

NOTES

TYPE 330 ELECTRONIC SWITCH

COMPONENT PARTS LIST

CAPACITORS

Symbol	Part Number	Description
C101	03011540	0.1 μf 600V Paper
C102	03150520	5-30 μμf 350V Variable Ceramic
C103	03128410	3-12 μμf 350V Variable Ceramic
C104	03055530	24 μμf ±10% 500V Mica
C105	Same as C102	
C106	Same as C103	
C107	03055850	510 μμf ±10% 300V Mica
C108	Same as C103	
C109	Same as C103	
C110	Same as C102	
C111	Same as C103	
C112	03133960	10 μμf 500V Composition
C113	Same as C112	
C114	03015920	0.01 μf 500V Ceramic
C115	03055040	30 μμf ±5% 500V Mica
C116	03133900	3.3 μμf ±10% 500V Composition
C117	03126620	0.1 μf ±10% 200V Paper
C118	03139610	0.02 μf 600V Ceramic
C119	03142900	1.5-7 μμf 350V Variable Ceramic
C201	Same as C101	
C202	Same as C102	
C203	Same as C103	
C204	Same as C104	
C205	Same as C102	
C206	Same as C103	
C207	Same as C107	
C208	Same as C103	
C209	Same as C103	
C210	Same as C102	
C211	Same as C103	
C212	Same as C112	
C213	Same as C112	
C214	Same as C114	
C215	Same as C104	
C216	03133920	4.7 μμf ±10% 500V Composition
C217	Same as C117	
C218	Same as C118	
C219	Same as C119	
C301	03143830	5-30 μμf 350V Variable Ceramic
C302	Same as C114	
C303	Same as C114	
C401	Same as C114	
C402	Same as C114	
C403	Same as C114	
C404	03133950	8.2 μμf ±10% 500V Composition
C405	Same as C114	
C406	Same as C114	
C407	Same as C115	
C408	Same as C115	
C409	Same as C114	
C410	Same as C114	
C411	Same as C114	
C412	03129340	1300 μμf ±5% 500V Mica
C413	03127140	0.015 μf ±10% 400V Paper
C414	03127270	0.18 μf ±10% 400V Paper
C415	Same as C114	
C416	Same as C114	
C501	03000220	4 μf 450V Elect.
C502	Same as C114	
C503	Same as C117	
C504	Same as C412	
C505	03158930	1 μf 400V Paper
C506	03019340	30 μf 450V Elect.
C507	Same as C117	
C508	Same as C114	
C509	Same as C114	
C510	Same as C112	
C511	Same as C114	
C512	Same as C114	
C513	Same as C114	
C514	03014080	80 μf 350V Elect.
C515	Same as C114	
C516	03146070	40 μf 250V Elect.
C517	Same as C516	
C518	03158600	150 μf 250V Elect.
C519	Same as C518	
C520A, B	03151460	20/80 μf Elect.
C521	Same as C514	
C522	Same as C114	
C523	Same as C114	

CRYSTALS

CR401	26000630	1N34
CR402	26000680	1N38
CR403	Same as CR402	

RECTIFIERS

CR501A, B	26001560	Metallic 1007
CR502	26001700	Metallic 1187
CR503	Same as CR502	
CR504A, B	26001590	Metallic 1008

FUSE

F501	11000790	3 Amp. (115V operation)
	11000770	1.5 Amp. (230V operation)

LAMP

I501	12007700	Light Ind.

CONNECTORS

J101	09029080	Coaxial
J201	Same as J101	
J301	Same as J101	
J401	51001290	Binding Post, Ins.
J402	51001400	Binding Post

INDUCTORS

L101	21006280	2.2 UH
L102	Same as L101	
L201	Same as L101	
L202	Same as L101	
L401	21013140	680 UH
L501	21004301	10 HY

RESISTORS

R101	02237620	1.8 Meg ±1% 1/2W, Film
R102	02237320	222000 ohms ±1% 1/2W, Film
R103	02237640	1.98 Meg ±1% 1/2W, Film
R104	02236990	20200 ohms ±1% 1/2W, Film
R105	02237540	1 Meg ±1% 1/2W, Film
R106	02237610	1.5 Meg ±1% 1/2W, Film
R107	02237650	2 Meg ±1% 1/2W, Film
R108	02237450	667000 ohms ±1% 1/2W, Film
R109	Same as R107	
R110	02032090	470000 ohms ±10% 1/2W
R111	02031590	33 ohms ±10% 1/2W
R112	Same as R111	
R113	02033410	510 ohms ±5% 1W
R114	Same as R111	
R115	Same as R113	
R116	02031650	100 ohms ±10% 1/2W
R117	01067800	500 ohms ±20%, Variable
R118	Same as R116	
R119	02224910	2500 ohms ±5% 5W, Wire Wound
R120	02032160	1.8 Meg ±10% 1/2W
R121	02031050	240000 ohms ±5% 1/2W
R122	Same as R116	
R123	02030430	620 ohms ±5% 1/2W
R124	02032130	1 Meg ±10% 1/2W

Symbol	Part Number	Description
R125	02032220	5.6 Meg ±10% 1/2W
R126	01016300	2000 ohms 1/2W, Variable
R127A, B, C	01064800	1 Meg/100000 ohms/1 Meg ±20%, Variable
R128	Same as R110	
R129	02031900	12000 ohms ±10% 1/2W
R130	Same as R129	
R131	02032120	820000 ohms ±10% 1/2W
R132	Same as R111	
R201	Same as R101	
R202	Same as R102	
R203	Same as R103	
R204	Same as R104	
R205	Same as R105	
R206	Same as R106	
R207	Same as R107	
R208	Same as R108	
R209	Same as R107	
R210	Same as R110	
R211	Same as R111	
R212	Same as R111	
R213	Same as R113	
R214	Same as R111	
R215	Same as R113	
R216	Same as R116	
R217	01060510	500 ohms ±20%, Variable
R218	Same as R116	
R219	Same as R119	
R220	Same as R120	
R221	Same as R121	
R222	Same as R116	
R223	Same as R123	
R224	Same as R124	
R225	Same as R125	
R226	Same as R126	
R228	Same as R110	
R229	Same as R129	
R230	Same as R129	
R231	Same as R131	
R232	Same as R111	
R302	02109360	20000 ohms ±5% 5W, Wire Wound
R303	02237250	146000 ohms ±1% 1/2W, Film
R304	02226170	300000 ohms ±1% 1W, Film
R305	Same as R111	
R306	Same as R111	
R307	02224920	3000 ohms ±5% 5W, Wire Wound
R308	Same as R111	
R401	02032170	2.2 Meg ±10% 1/2W
R402	Same as R110	
R403	Same as R121	
R404A,B,	01058661	100000 ohms/20000 ohms, Variable. (Part of Switch Assy. 05009653)
R406	02030990	130000 ohms ±5% 1/2W
R407	02033580	2700 ohms ±5% 1W
R408	02031030	200000 ohms ±5% 1/2W
R409	02031000	150000 ohms ±5% 1/2W
R410	02225020	10000 ohms ±5% 5W, Wire Wound
R411	Same as R111	
R412	02030720	10000 ohms ±5% 1/2W
R413	02033630	4300 ohms ±5% 1W
R414	02031020	180000 ohms ±5% 1/2W
R415	02031070	300000 ohms ±5% 1/2W
R416	Same as R414	
R417	Same as R413	
R418	Same as R415	
R419	02036640	4700 ohms ±5% 2W
R420	02030500	1200 ohms ±5% 1/2W
R421	Same as R420	
R422	02036720	10000 ohms ±5% 2W
R423	Same as R422	
R424	02030670	6200 ohms ±5% 1/2W

Symbol	Part Number	Description
R501	Same as R110	
R502	02032100	560000 ohms ±10% 1/2W
R503	02032070	330000 ohms ±10% 1/2W
R504	01060620	200000 ohms ±20%, Variable
R505	Same as R110	
R506	02031600	39 ohms ±10% 1/2W
R507	02224950	4500 ohms ±5% 5W, Wire Wound
R508	Same as R116	
R509	02109380	25000 ohms ±5% 5W, Wire Wound
R510	Same as R502	
R511	02037540	12 ohms ±10% 2W
R512	Same as R511	
R513	02237230	120000 ohms ±1% 1/2 W, Film
R514	Same as R502	
R515	02031770	1000 ohms ±10% 1/2W
R516	02037590	33 ohms ±10% 2 W
R517	02237190	100000 ohms ±1% 1/2W, Film
R518	02237390	387000 ohms ±1% 1/2W, Film
R519	Same as R102	
R520	Same as R101	
R521	01060040	50000 ohms ±20%, Variable
R522	02030910	62000 ohms ±5% 1/2W
R523	Same as R515	
R524	Same as R110	
R525	Same as R502	
R526	02037920	18000 ohms ±10% 2W
R527	02224960	5000 ohms ±5% 5W, Wire Wound
R528	Same as R111	

REGULATOR

RT501	02235260	Current Regulator

SWITCHES

S101	05009632	Rotary 3P6T (Part of Sw. Assy. 05009631)
S102	Same as S101	
S201	05009633	Rotary 2P4T (Part of Sw. Assy. 05009631)
S202	Same as S201	
S401	05009654	Rotary 2P2T (Part of Sw. Assy. 05009653)
S402	05009641	Rotary 3P4T
S501	05001130	Toggle SPST
S502	05000420	Slide DPDT

TRANSFORMER

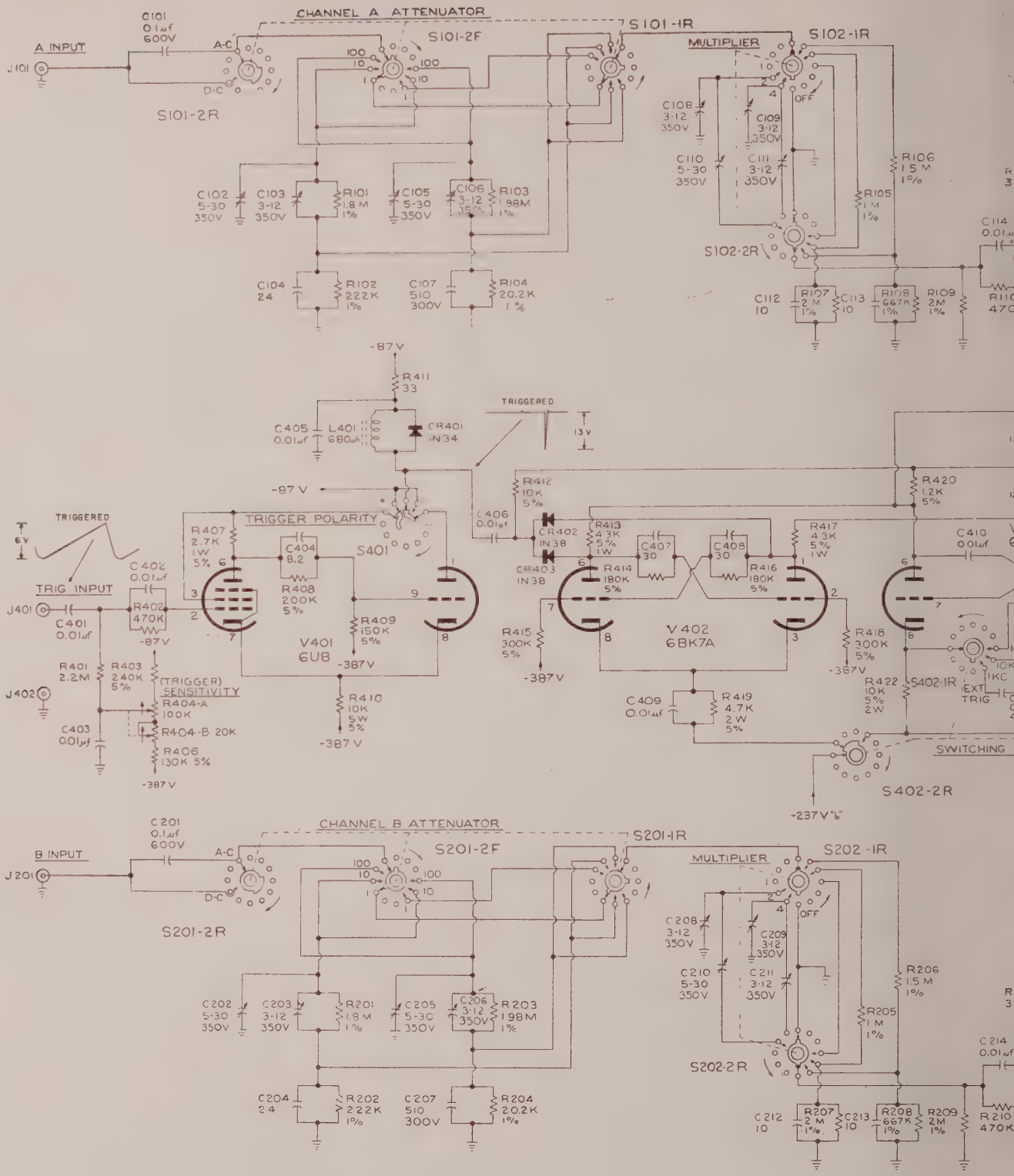
T501	20007341	Power

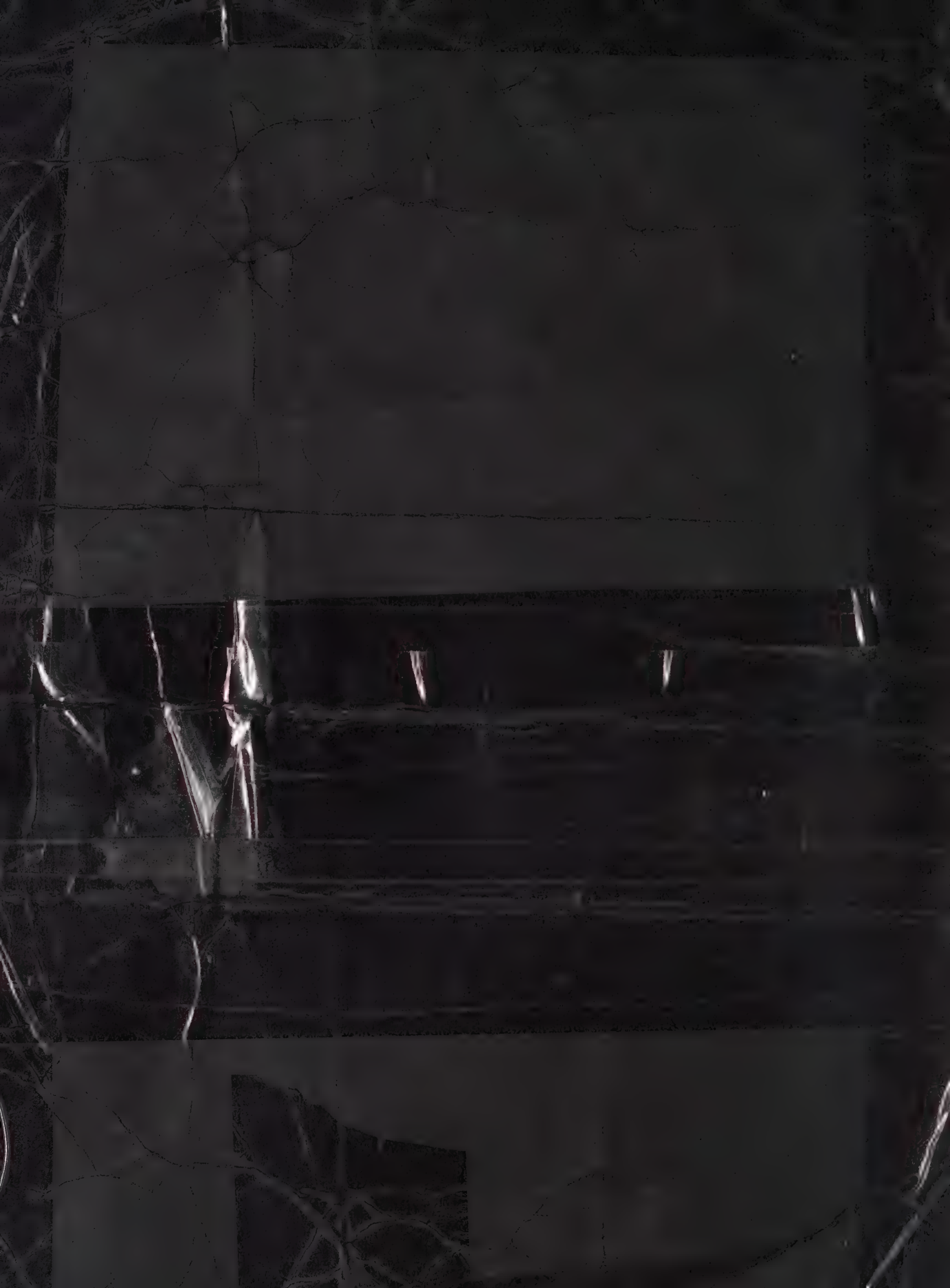
TUBES

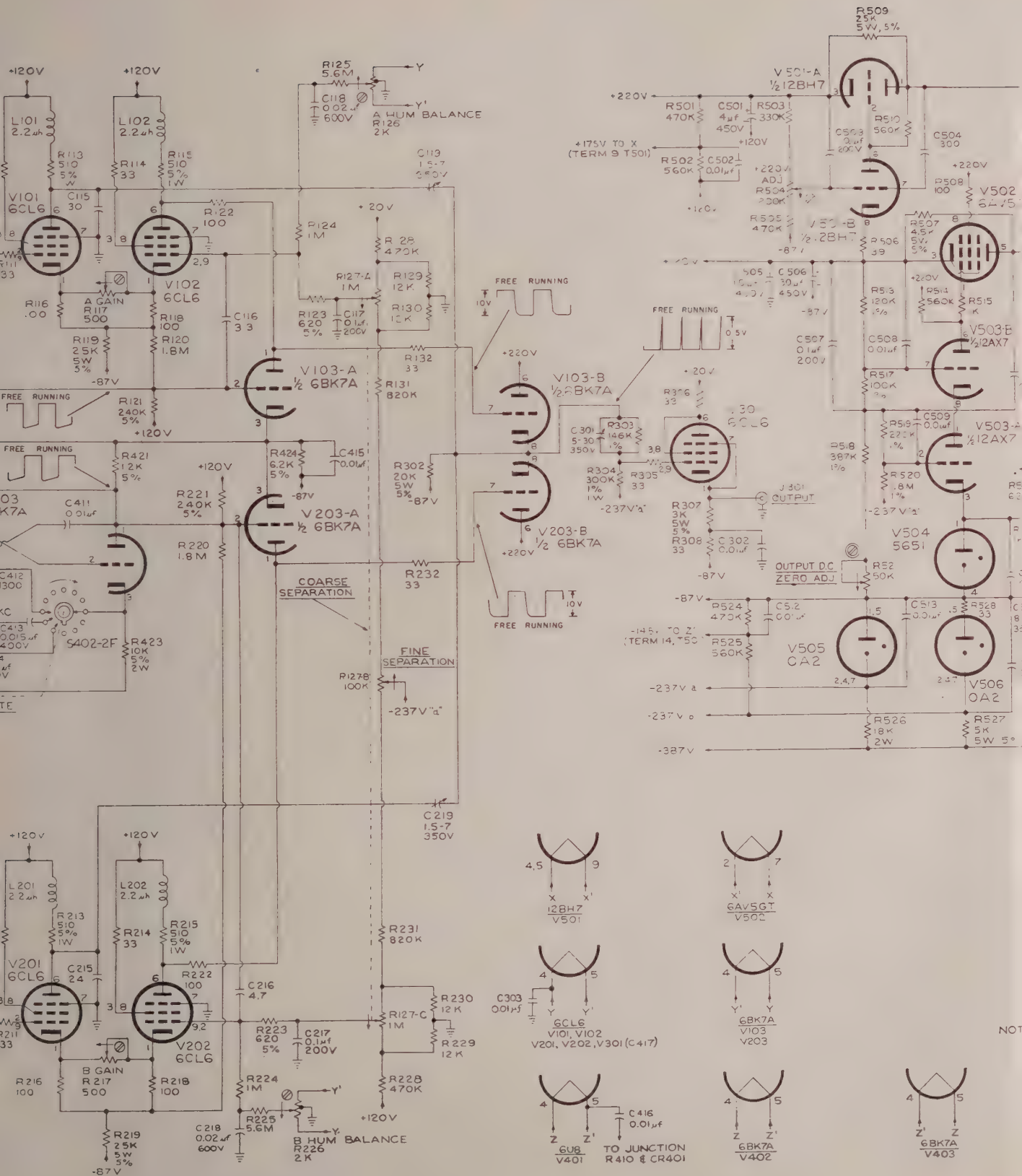
V101	25007820	6CL6
V102	Same as V101	
V103	25008560	6BK7A
V201	Same as V101	
V202	Same as V101	
V203	Same as V103	
V301	Same as V101	
V401	25007310	6U8
V402	Same as V103	
V403	Same as V103	
V501	25005030	12BH7
V502	25007610	6AV5GT
V503	25001500	12AX7
V504	25000810	5651
V505	25000300	OA2
V506	Same as V505	

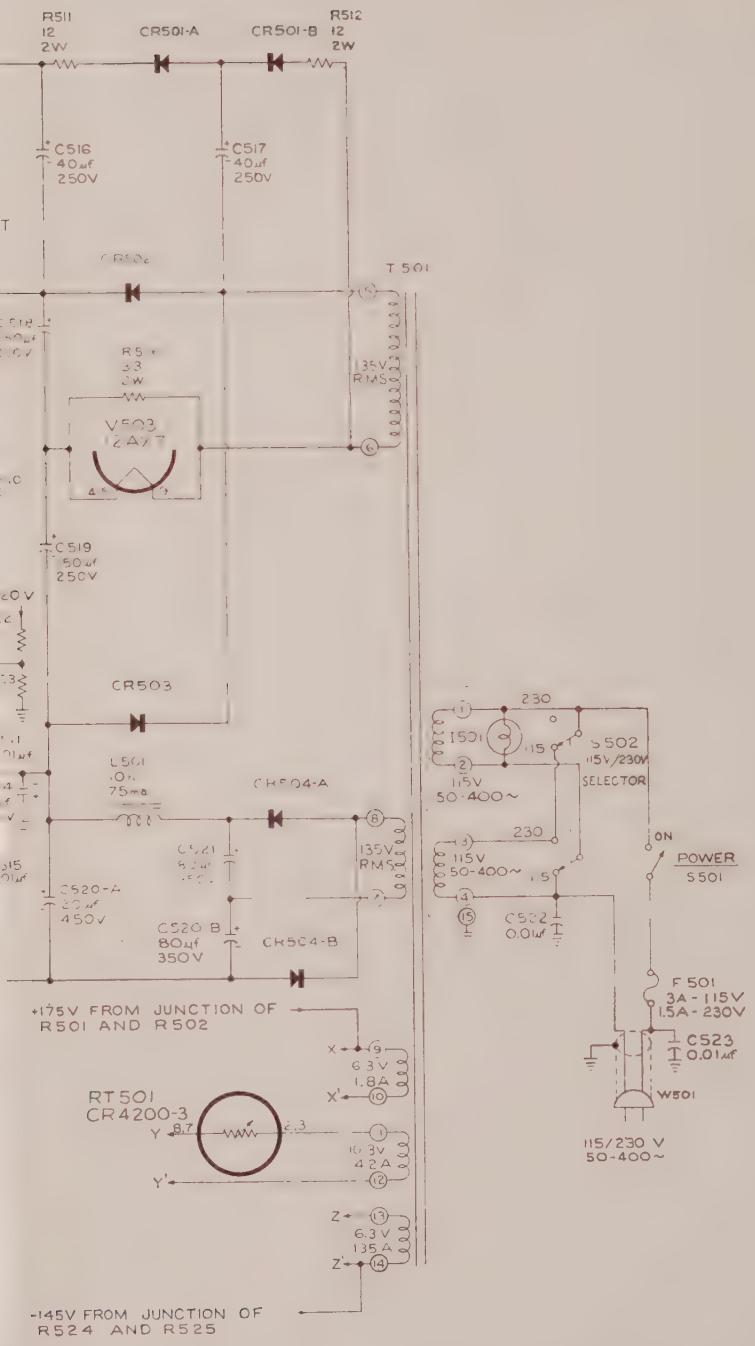
CABLE

W501	50093151	Power


CHANNEL A ATTENUATOR
A INPUT
J101
C101 0.1μf 600V
A-C
D-C
S101-2R
S101-2F
S101-1R
MULTIPLIER
S102-1R
S102-2R
OFF
C102 5-30 350V
C103 3-12 350V
R101 1.8 M 1%
C105 5-30 350V
C106 3-12 350V
R103 1.98M 1%
C104 24
R102 222K 1%
C107 510 300V
R104 20.2K 1%
C108 3-12 350V
C109 3-12 350V
C110 5-30 350V
C111 3-12 350V
R106 1.5 M 1%
R105 1 M 1%
C112 10
R107 2 M 1%
C113 10
R108 667K 1%
R109 2M 1%
C114 0.01μf
-87V
R411 33
C405 0.01μf
L401 680μh
CR401 IN34
TRIGGERED
13V
-87 V
R412 10K 5%
C406 0.01μf
CR402 IN38
CR403 IN38
R413 4.3K 5% 1W
C407 30
C408 30
R414 180K 5%
R416 180K 5%
R417 4.3K 5% 1W
R420 1.2K 5%
C410 0.01μf
V402 6BK7A
R415 300K 5%
-387V
R418 300K 5%
R422 10K 5% 2W
S402-1R
EXT TRIG
10K
1KC
C409 0.01μf
R419 4.7K 2W 5%
SWITCHING
S402-2R
-237V"b"
TRIGGERED
6V
TRIGGER POLARITY
S401
R407 2.7K 1W 5%
C404 8.2
R408 200K 5%
R409 150K 5%
V401 6U8
-387V
R410 10K 5W 5%
C402 0.01μf
TRIG INPUT
J401
R402 470K
C401 0.01μf
-87V
R401 2.2M
R403 240K 5%
(TRIGGER) SENSITIVITY
R404-A 100K
R404-B 20K
R406 130K 5%
C403 0.01μf
J402
CHANNEL B ATTENUATOR
B INPUT
J201
C201 0.1μf 600V
S201-2R
S201-2F
S201-1R
MULTIPLIER
S202-1R
S202-2R
C202 5-30 350V
C203 3-12 350V
R201 1.8 M 1%
C205 5-30 350V
C206 3-12 350V
R203 198M 1%
C204 24
R202 222K 1%
C207 510 300V
R204 20.2K 1%
C208 3-12 350V
C209 3-12 350V
C210 5-30 350V
C211 3-12 350V
R206 1.5 M 1%
R205 1 M 1%
C212 10
R207 2 M 1%
C213 10
R208 667K 1%
R209 2M 1%
C214 0.01μf
R210 470K




+120V
L101 2.2 μh
L102 2.2 μh
R113 510 5% ½W
R114 33
R115 510 5% 1W
V101 6CL6
V102 6CL6
C115 30
R122 100
R116 .00
A GAIN R117 500
R118 100
R119 25K 5W 5%
R120 1.8M
-87V
C116 33
R125 5.6M
C118 0.02 μf 600V
A HUM BALANCE R126 2K
C119 1.5-7 350V
+20V
R124 1M
R 28 470K
R127-A 1M
R129 12K
R123 620 5%
C117 0.1 μf 200V
R130 12K
FREE RUNNING
10V
0.5V
V103-A ½ 6BK7A
V103-B ½ 6BK7A
R132 33
R131 820K
+220V
R121 240K 5%
R421 1.2K 5%
R424 6.2K 5%
C415 0.01μf
R302 20K 5W 5%
R221 240K 5%
V203-A ½ 6BK7A
V203-B ½ 6BK7A
C411 0.01μf
R220 1.8M
R232 33
COARSE SEPARATION
FINE SEPARATION
R127-B 100K
-237V "a"
S402-2F
R423 10K 5% 2W
C219 1.5-7 350V
R509 25K 5W, 5%
V501-A ½ 12BH7
R501 470K
C501 4 μf 450V
R503 330K
+175V TO X (TERM 9 T501)
R502 560K
C502 0.01μf
R504 ADJ 250K
R505 470K
V501-B ½ 12BH7
R506 39
C503 0.1μf 200V
R510 560K
C504 300
R508 100
V502 6AV5
R507 4.5K 5W 5%
C505 10μf 450V
C506 30μf 450V
R513 120K
R514 560K
R515 1K
V503-B ½ 12AX7
C507 0.1μf 200V
C508 0.01μf
R517 100K
V503-A ½ 12AX7
C509 0.01μf
R519 220K
R518 387K
R520 1.8M
-237V "a"
V504 5651
J 301 OUTPUT
R307 3K 5W 5%
R308 33
C302 0.01μf
OUTPUT D.C. ZERO ADJ
R52 50K
R524 470K
C512 0.01μf
C513 0.01μf
R528 33
-145V TO Z' (TERM 14, T501)
R525 560K
V505 CA2
V506 CA2
-237V a
-237V o
R526 18K 2W
R527 5K 5W
-387V
V201 6CL6
V202 6CL6
L201 2.2 μh
L202 2.2 μh
R213 510 5% ½W
R214 33
R215 510 5% 1W
C215 24
R222 100
R216 100
B GAIN R217 500
R218 100
R219 25K 5W 5%
C216 4.7
R223 620 5%
C217 0.1μf 200V
R224 1M
R225 5.6M
C218 0.02μf 600V
B HUM BALANCE R226 2K
R231 820K
R230 12K
R229 12K
R228 470K
C303 0.01μf
C416 0.01μf
TO JUNCTION R410 & CR401
12BH7 V501
6AV5GT V502
6CL6 V101, V102 V201, V202, V301 (C417)
6BK7A V103 V203
6U8 V401
6BK7A V402
6BK7A V403



ES:
1. ALL CAPACITORS ARE IN MICROMICROFARADS AND 500V UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE 1/2 WATT, ±10% UNLESS OTHERWISE SPECIFIED.
3. ALL SWITCHES ARE SHOWN IN MAXIMUM COUNTERCLOCKWISE POSITION AS VIEWED FROM FRONT PANEL.
4. ARROWS ON POTENTIONMETERS AND SWITCHES INDICATE CLOCKWISE ROTATION.
5. ⊘ DENOTES SERVICE ADJUSTMENT.
6. ⊘ DENOTES FRONT-PANEL SERVICE ADJUSTMENT.

Schematic of Circuit
Du Mont Type 330 Electronic Switch
Ref. Drwg. 98000831-4
Issue 4

WARRANTY AND SERVICE NOTICE
for
Industrial Type Cathode-ray Tubes and Instruments

DU MONT INSTRUMENTS

Each instrument manufactured by the Instrument Division of Allen B. Du Mont Laboratories, Inc., is guaranteed to equal or exceed its published performance specifications. It is further guaranteed against defective materials (other than the cathode-ray tube) and workmanship for a period of one year from date of delivery. Any defective instrument or an instrument that does not meet or exceed our specifications will, upon inspection by us, be repaired or replaced at our discretion should such defect appear within the guarantee period.

To register this guarantee, the enclosed guarantee card must be properly filled out and mailed to the factory immediately upon receipt of the equipment. Complete information is necessary. BOTH THE TYPE NUMBER AND THE SERIAL NUMBER OF THE INSTRUMENT MUST BE GIVEN ON THIS CARD.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

DU MONT CATHODE-RAY TUBES

Industrial type cathode-ray tubes manufactured by Allen B. Du Mont Laboratories, Inc., are guaranteed for 1000 hours of operation or for a six-month period of installation, whichever shall first expire. The right is reserved, however, to limit claims to a period of nine months after shipment from the factory. Adjustments will be made on the merit of each individual claim because of the widely varying applications to which such tubes are subjected, and a tube which becomes defective during the guarantee period will be replaced ONLY AFTER INSPECTION AT THE FACTORY. Cathode-ray tubes which are sent in under the guarantee, must be sent with transportation paid.

BURNED OUT HEATERS AND BROKEN GLASS ARE NOT COVERED BY THE TUBE GUARANTEE

To register a tube guarantee, the guarantee card enclosed with the tube must be properly filled out and mailed to the factory immediately upon receipt of the equipment. Complete information is necessary. TYPE NUMBER AND SERIAL NUMBER OF THE CATHODE-RAY TUBE MUST BE INCLUDED. The serial number of the tube will be found either on the glass stem of the electro-gun structure or on the bulb near the Du Mont brand. Tubes must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time and to furnish merchandise in accordance with current specifications without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications excepting under the classification of special apparatus.

SERVICE

In order to insure factory service under our guarantees, the guarantee cards enclosed with all instruments and tubes must be properly filled out and returned. In all cases where service or adjustment is requested, please write first to the factory giving complete information concerning the nature of the failure and describing the manner in which the equipment was used when failure occurred. THE TYPE NUMBER AND SERIAL NUMBER of the equipment must also be given. In this way, much time can be saved and unnecessary inconvenience often avoided. When writing in this respect, address:

Allen B. Du Mont Laboratories, Inc.
Instrument Service Department
760 Bloomfield Avenue, Clifton, New Jersey

The Instrument Service Department will then send to the customer, the written procedure for sending the instrument back to the factory. All equipment should be packed and shipped in accordance with this procedure; and identification tags should be attached to each tube or instrument.

REPLACEMENT PARTS

If it is necessary to order a replacement component from the factory, always give the type number and serial number of the instrument and refer to the component by its symbol designation and description on the circuit schematic. This will help to expedite service.

DU MONT

Additional copies of this manual may be secured at a cost of one dollar each or ten dollars per dozen copies; postpaid in the United States of America only.

Allen B. Du Mont Laboratories, Inc.

Instrument Division

760 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY